In the present invention, a compact burner chamber employing a radiant burner assembly is configured to distribute radiant energy along the axial length of a tubular reaction chamber. In one embodiment, the radiant burner assembly comprises a woven metal fiber attached to a support structure that permits the efflux of fuel and oxidant from the burner core to the outer surface of the metal fiber. The properties of the metal fiber stabilize the combustion in a shallow zone proximal to the outer surface of the metal fiber. The combustion reaction heats the metal fiber to incandescence and provides a source of radiant energy that is transferred to the reaction chamber. In another embodiment, the radiant burner assembly comprises a porous ceramic fiber burner that accomplishes the same object by serving as a radiant source of energy.

The metal fiber of the burner typically consists essentially of an alloy containing principally iron, chromium, and aluminum and smaller quantities of yttrium, silicon, and manganese having extended life at operating temperatures up to 2000°F.

In one embodiment, the tubular reaction chamber has U-shape, and is sometimes referred to as a hairpin tube, which is substantially filled with catalyst, the tube extending into and out of the combustion chamber for gaseous flow through. The radiant burner axis is preferably vertically disposed within the combustion chamber and oriented parallel to the axis or axes of the U-tube reaction chamber. The active radiant surface of the cylindrical radiant burner assembly is defined by a geometric arc that bisects the cylindrical assembly so as to maximize the flux of radiant energy that is directed to the surface of the U-tube reaction chamber. In this embodiment, the center to center spacing between the radiant burner and the U-tube reaction chamber, and the radiation angle of the radiant burner are simultaneously controlled, or configured for high efficiency of heat transfer.

In a third embodiment, the tubular reaction chamber comprises a helical coil that is substantially filled with catalyst and has inlet and outlet portions that pass into and out of the combustion chamber. The helical coil is wrapped to form turns at specific lead

angles, so that the coil free area is in the range of 50% to 75%, wherein the free area is defined by the ratio of the free area between helical tube conduits or turns and the cylindrical surface that bisects the helical coil circle or cylinder. The radiant burner axis is typically vertically disposed within the combustion chamber and the cylindrical radiant burner is located at the center of the helical coil. In this embodiment, the active radiant surface of the cylindrical radiant burner assembly is defined by a 360-degree arc.

In each embodiment, the radiant burner is operated at a combustion intensity and an excess air ratio that is carefully controlled to limit the radiant burner surface temperature to less than 2000°F, and preferably in the range of 1500°F to 1900°F, in order to provide extended life for the radiant burner.

In each embodiment, the catalyst particle diameters and reactant mass velocities are carefully controlled to simultaneously limit the reactor pressure drop to less than 8 psi, and preferably in the range of 2 psi to 4 psi in order to limit the